le mouvement du plateau est contrôlable soit en fixant des paramètres (fréquence ou amplitude des oscillations. . .), soit en faisant « réagir » le plateau au mouvement du sujet. Ces deux comportements ont été programmés sous la forme de deux lois de commandes : le mode actif et le mode réactif.
Discussion.– Cette plateforme est constituée de quatre systèmes de mesures d'efforts (pieds et mains) et d'un plateau mobile dans toutes les directions de l'espace de façon contrôlée. Les résultats préliminaires confirment que les résultats mesurés en statique sont comparables à ceux d'une plateforme de stabilométrie de référence. Nous procédons actuellement à l'élaboration d'un protocole expérimental d'évaluation de l'équilibre dynamique dans plusieurs populations de patients.

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P007-f

Effet de l'entraînement robotisé sur les paramètres biomécaniques de la marche chez des sujets hémiplégiques adultes

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Mots clés : Hémiplégie chronique ; Rééducation robotisée ; Locomotion
Objectif.– L'hémiplégie est une perte plus ou moins complète de la motricité volontaire d'un hémicorps suite à une lésion cérébrale, entraînant généralement des altérations de l'appareil locomoteur avec des troubles persistants du mouvement et de la posture. Plusieurs études [1–3] ont mis en évidence différents profils de schéma de marche chez les hémiplégiques. Nous nous sommes intéressés pour cette étude au schéma de marche dit « stiff knee gait » avec pour objectif principal de mettre en évidence le rôle d'une rééducation robotisée dans l'amélioration ou la modification du schéma de marche chez des adultes hémiplégiques chroniques [4].
Matériel/Patients et méthodes.– Les données ont été recueillies par un système d'analyse du mouvement (Vicon®–Oxford Metrics, Oxford, UK) afin de réaliser une analyse quantifiée de la marche (AQM) avant et après une rééducation robotisée (Lokomat®) intensive de quatre séances par semaine pendant cinq semaines sur neuf adultes hémiplégiques chroniques.
Résultats.– Les résultats montrent une amélioration :
– des paramètres locomoteurs (vitesse de marche, longueur du pas et cadence associées à une diminution du temps d'appui du côté sain) ;
– des équilibres statique et dynamique ;
– de la flexion du genou du côté atteint en phase oscillante.
Discussion.– L'aide robotisée permet au sujet d'acquérir un nombre significativement supérieur d'informations sensori-motrices par rapport à une rééducation normale. Cette première étude apporte la preuve expérimentale de l'importance et de l'utilité de la rééducation robotisée comme aide à la rééducation du schéma de marche chez des adultes hémiplégiques chroniques.
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Posters
English version

P001-e

Organization of postural equilibrium in several planes in ballet dancers

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Keywords: Balance; Ballet dance; Age; Ground reaction forces
Introduction.– This study analyzed the balance strategies of ballet dancers during postural equilibrium in three single leg balance conditions with and without the use of vision and regard to age.
Method.– Dancers participating in the experiment formed two groups of 20 dancers each, one aged between eight and 16 years (young group) and the other aged between 17 and 30 years (adult group). Ground reaction forces (mediolateral–ML, anteroposterior–AP components, vertical–V) were recorded during three kinds of postural equilibrium, gesturing limb toward the front, the side, and to the rear, and under two conditions, eyes open and eyes closed. Results analysis enabled us to extract some spatiotemporal data for each component of the ground reaction force–GRF (frequency–number of GRF oscillations, variability of GRF and impulses–force × time).
Results.– Young dancers are characterized, compared to adult dancers, by an instability (increase in the number of falls) combined with an increase of mean frequency oscillations and a GRF variability decrease mainly visible on the ML component. Comparisons for each group show that the absence of vision implies an AP, ML and V impulsions increase combined with a GRF variability increase. Balance with the gesturing limb to the rear increases the age and vision effect compared to balances with the limb forward or to the side.
Discussion.– Indeed, the results obtained show very specific characteristics related to age and visual influence according to the condition studied. Young dancers are less efficient at controlling their balance than adult dancers. This observation may be related to the number of hours practicing dance, which differs between groups. These observations offer some recommendations for physical conditioning and potential injury prevention secondary to balance disorders.

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P002-e

Stabilometry: A tool for measurement of anticipatory postural adjustment by paravertebral muscles

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Introduction.– An anticipatory contraction of the paravertebral muscles preceding the performance of upper-limb extension tasks is known since a while. Its clinical perception is nevertheless difficult. We suggest usage of a force platform as a tool for detecting the anticipatory postural adjustment (APA).
Method.– Thirty healthy subjects, 15 males-15 females, from 20 to 30 years-old were studied by a surface electromyography equipped with a video (Biogesta®) which was monitoring the deltoid muscles and long dorsal muscles, with at the same time, a monitoring on force platform (Satel®). Each person was evaluated for 12 seconds. After 4 seconds, a beep required the person extends the arms as fast as possible. Each upper-extremity was ballasted by a weight of one kilogram for increasing the muscular recruitment. After 8 seconds, a second beep required the person stands at attention.

Results.– The dynamic EMG has allowed us to confirm that anticipated contractions of the paravertebral muscles (preceding the deltoid muscles contraction) are for 90% of our population, correlated with a APA: a shift in Y is observed in the stabilometry monitoring. This APA shows a backward shift of the center of gravity, of 3.98 mm in average on the Y-axis due to the requested movement. The remaining 10% of healthy subjects without APA do not have either anticipated paravertebral recruitment, observed by EMG.
Conclusion.– This stabilometry approach of APA which measures the anticipatory movement of paravertebral muscles when extending upper-limbs gives us a sensitive and specific tool. Its systematic usage in the caring of lombalgic patients is under study.

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P003-e

Hip-ankle coordination strategy of stroke patients in dynamic condition

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Keywords: Frontal postural strategy; Hemiplegia; Double inverted pendulum; Hip and ankle relative phase; Anti-phase pattern; Preferential motor coordination

The aim of this Master's thesis is related to the postural behaviour in quiet standing of stroke patients with hemiplegia in static and dynamic condition. The human quiet stance is often modelled as a single-link inverted pendulum pivoting only around the ankle joints in the sagittal plane. Several recent studies have shown that this single-link inverted pendulum doesn't take into account simultaneous ankle and hip movements. In order to show specific ankle-hip coordination, we decided to use a tri-pendulum model (quite similar to the double-link inverted pendulum model). This study looked in particular at the frontal plane because hemiplegic standing is more largely disturbed in this plane.
To do so, the measurement protocol used is based on a dual-plate force platform and 3D movement capture system coupling. Twelve stroke patients with hemiplegia and a control group (forty one subjects) participated to this study. In the static evaluation, stroke patients present an increased ankle and hip range of motion, and a preferential hip-ankle angular variation in anti-phase pattern in the two planes is observed for all participants (without excluding the existence of a hip-ankle in-phase pattern). In the dynamic evaluation, during the central ball avoidance test, only stroke patients who can attest a preferential motor pattern produced a hip-ankle anti-phase pattern in the frontal plane contrary to the control group (who also have a behaviour in-phase but to a lesser extent). All this data has enabled us to show the relevance of this model in the frontal plane. It would be interesting to carry out this study further and include a larger number of subjects and determine the relevance of this variable (relative phase) both in the evaluation and its integration into rehabilitation approaches through biofeedback and virtual environment techniques.

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P004-e

Balance assessment of hemiplegic subjects on a robotic dynamic posturography platform "IsiMove"

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Keywords: Balance; Hemiplegia; Dynamic platform; Robotic

Objectives.– Balance disorders are common in hemiplegia and can be assessed in clinical or instrumental way on force platforms. The aim of this study is to show preliminary results of balance evaluation in hemiplegia patients tested on a new robotic dynamic posturography platform: "IsiMove".
Patients.– Ten healthy subjects (age: 51(26), 5 females and 5 males) and ten hemiplegia patients (age: 57(30), 6 females and 4 males) were selected. Six of them have right-sided hemiparesis and all of them can stand without assistance.
Methods.– The study was done in the Neuro-orthopedic rehabilitation service of Rothschild hospital (APHP). The "IsiMove" platform is a robotic dynamic platform designed by the Institut des Systèmes Intelligent et de Robotique (ISIR-UPMC) and developed by AssistMov society. The experimental protocol performed on the IsiMove consists of five exercises. Each exercise consists of a sequence of movements: rotation around X axis and Y axis, translation around Y axis, rotation around Z axis and translation around X axis. Each movement was performed in 10 s. But performed at various frequencies: 0.1 Hz, 0.2 Hz, 0.3 Hz, 0.4 Hz and 0.5 Hz, in which the subjects must stand still, eyes open, without leaning on the side bars.
Results.– For analysis results we used the main dynamic parameters. The Equilibrium Score (ES), a modified Postural Instability Index (PSI) and the Right-left forces ratio on feet. The results of the first two parameters were not relevant, probably because the movement of the platform during the protocol was not disturbing enough. However, the right-left force ratio has allowed us to characterize the support asymmetry among patients, and the behaviour difference between healthy subjects and subjects with hemiplegia.
Discussion.– This is the first experience using a robotic dynamic posturography platform. New protocols more disturbing with random velocity are necessary for equilibrium analysis. In addition, these protocols could be applied to the evaluation of other pathologies as well as to their rehabilitation.

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P005-e

Influence of two modes of visual deprivation on postural stability and gait in healthy subjects

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Introduction.– Three main systems are involved in postural stability: vestibular, visual, proprioceptive. It is known that "visual dependence" concerns many healthy subjects (excessive reliance on the visual afference, even when it is not available or provides inaccurate information). Balance rehabilitation without visual information can be conducted either with eyes closed or eyes open in the dark. These conditions do not have the same impact on posture when recorded on platform [1]. There are no studies about the impact of these conditions on gait.
Objectives.– Observe any differences in the gait when subject's eyes are closed (EC) or open in darkening glasses (EODG).
Materials and methods.– 1-Recruitment: 18 healthy subjects (20-40 years). 2 - Procedure: Gait analysis on GAITRite walkway. The analysis focuses on the speed, stride length, the double stance time, the deviation from the axis of walking, FAP score (average of three recording).
Results.– There was a significant difference (Wilcoxon test) between the two conditions, walking under EODG condition being more difficult than under EC condition: increase of the double stance time (30 vs 28% $P = 0.002$), decrease of the speed (99 cm/s vs 107, $P = 0.002$, increase of the deviation (5.13° vs 4.76°, $P = 0.03$).